(cf. Sarnoff & Zimbardo, 1961).

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Alternation behavior of children in a cross-maze

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Seventy-five children of preschool age were observed in a cross-maze. The frequency of alternation increased with age for the Ss who started both trials from the same start position but did not change across age for the Ss who started the two trials from opposite start stems. Running time decreased with increasing age under both conditions.

Age has been shown to be a factor in spontaneous alternation of hamsters (Kirkby & Lackey, 1968), in exploratory behavior of rats in an exploration box (Hughes, 1968a, b), in exploratory behavior of rats in an open field (Goodrick, 1967), and in exploratory behavior of rats in a Y-maze (Williams, Carr, & Peterson, 1966). In general, the effect is one of increasing exploratory behavior with increasing age, but there is some indication that the relation is nonmonotonic. Additionally, it has been shown that age affects alternation behavior of children in a light guessing situation (Manley & Miller, 1968; Miller, Tu, Moffat, & Manley, 1969). Seven-year-old Ss alternated more than 4-, 6-, 8-, or 10-year-old children.

The present study deals with the alternation behavior of preschool children in a cross-maze. The cross-maze (Glanzer, 1953) has been used extensively to compare predictions based on stimulus satiation theory with those based on Hull's (1943) concept of reactive inhibition. While stimulus satiation theory seems to explain more adequately the phenomenon of spontaneous alternation in the rat, there have been no studies comparing the two theories at the human level. The most obvious reason for this lack of data is the difficulty of devising a human maze. Children, rather than adults, served as Ss in the present study, thus reducing somewhat the difficulty of constructing a maze and allowing for the evaluation of changes in alternation behavior as a function of age.

SUBJECTS

The Ss were 75 preschool children from two day care centers in upper middle class neighborhoods; their ages ranged from 2 years 2 months to 6 years 11 months. Approximately one-half of the Ss were male, and sex was balanced as nearly as possible across conditions.

APPARATUS

A cross-maze was set up by putting together four identical tunnels through which the Ss could crawl. The tunnels, which are commercially available from toy manufacturers, were made from cloth covering a large metal coil. The tunnels were 8 ft long and 24 in. in diam. Posterboard was used to block the tunnel opposite the starting point so that on each trial S was faced with a standard T-maze choice situation.

PROCEDURE

Ss at each of four age levels, 3, 4, 5, and 6, were assigned randomly to one of two groups. Ss in one group (same) entered the same start stem of the maze on each of two trials, while in the second group (different) Ss entered the maze from one start stem on the first trial and from the opposite stem on the second trial.

The very young Ss, some of whom were hesitant to go with E, were allowed to bring a friend. In these cases, the starting point for the second child was rotated 90 deg, and the opposite experimental condition was assigned to him to make imitative behavior impossible.

The test location in one school was a large empty assembly hall and in the other, an isolated corner of an outdoor play area bounded on three sides by woods and on the fourth by the school building. In each case, the starting points were oriented to minimize the differences between external stimuli at the ends of the arms of the T. Ss from the two schools were divided approximately equally between conditions to control for possible differential effects of the two test situations.

E recorded the choice on each trial. Additionally, running time from S's entrance into the start stem to S's exit from one of the choice arms was measured with a hand-operated stopwatch.

E approached each S individually in his classroom and invited him to play a very short game. When E and S entered the test area, E gave S the following instructions: "See, I have these big tunnels that you can crawl through. You can play *two* times. You start here, and when you come to the end of the first tunnel, you'll see that the road is blocked. You can go whichever way you want to when you get there. Are you ready? Go!" When S emerged, E directed him to the proper entrance for the second trial

Table 1
Number of Ss and Percent Alternation

Start Position	Age Levels 3 Same	3 Different	4 Same	4 Different	5 Same	5 Different	6 Same	6 Different
Number of Ss	10	8	10	10	9	10	10	8
Percent Alternation	.20	.375	.500	.100	.667	0	.900	.250

and said, "Are you ready? Go!" The use of any terms which might induce the S to repeat or to change his response was avoided.

RESULTS

Alternation and repetition were defined in terms of the S's turning response rather than in terms of the maze arms. Thus, an alternation occurred if the child turned first left and then right, regardless of the start stem location. The differences between males and females on rate of alternation were not significant. Thus, all analyses are for data combined across sex. The rate of alternation for Ss in the same-start-position condition was 56.4%, which does not differ from chance, $Z = .80$, $p > .05$. For the different-start-position condition, the rate was 16.7%, which is well below the chance level, $Z = 5.38$, $p < .01$. Additionally, these group rates are significantly different, $\chi^2 = 13.13$, $df = 1$, $p < .001$ (Cohen, 1967). Since the number of left choices differed markedly for the same and different groups, an adjustment suggested by Douglas (1966) was applied to these rates. The change resulting from this adjustment was slight and did not affect the significance statements.

Since the alternation rates differed as a function of start position, the same and different groups were analyzed separately across age. As can be seen from Table 1, which shows the rate of alternation and the number of Ss in each group, the rate of alternation increased consistently across ages for the same condition, $\chi^2 = 17.37$, $df = 3$, $p < .005$. A trend analysis (Cohen, 1967) yielded a significant linear trend, $\chi^2 = 12.62$, $df = 3$, $p < .01$, but no other trends were significant. Thus, with increasing age there is a greater tendency to make a different response, to enter a different arm, or both, and since in this condition stimulus alternation and response alternation are confounded, it cannot be determined which is dominant.

For the different condition, there were no significant differences in alternation rates across the four age groups. In each group, the alternation rate was well below a chance level, indicating a tendency to explore on Trial 2 the arm that was not entered on Trial 1. In this condition, any tendency to alternate responses conflicts with the tendency to alternate stimuli, i.e., S can alternate with respect to only one of these events.

Trial times were recorded for each S and transformed to log times for analysis. On both Trials 1 and 2, the running time was a decreasing function of age, $F(3,67) = 17.59$, $p < .01$, and $F(3,67) = 18.00$, $p < .01$, but no other variables affected running time. Thus, time is relatively uninformative in studies of children's alternation behavior in a cross-maze.

DISCUSSION

The increased rate of alternation obtained with Ss who started from the same start position on each of two trials is in agreement with the results from studies with human Ss performing other tasks (Manley & Miller, 1968; Miller, Tu, Moffat, & Manley, 1969) and from studies with animals (Goodrick, 1967; Hughes, 1968a, b; Kirkby & Lackey, 1968; Williams, Carr, & Peterson, 1966). It appears that the rate of alternation increases linearly over ages 3 to 6, as shown in the present study. However, the increase does not continue linearly, since Miller et al (1969) found that 7-year-old children alternated at a higher rate than 10-year-olds, and Manley & Miller (1968) found that 7-year-old Ss alternated at a higher rate than 8-year-old Ss. Thus, it seems that, under constant conditions, the alternation rate increases until the child is 7 years old and then perhaps declines or remains stable. The form of the function is indeterminant beyond 7 years.

The data for the same start position are similar to results with animal Ss. Kirkby & Lackey (1968) found an increasing rate of alternation in 20-, 50- and 150-day-old male hamsters. The youngest animals alternated randomly, as did young children in the present study. Hughes (1968b) found that young rats traveled shorter distances and spent less time exploring than did older rats. Additionally, Williams et al (1966) found an increase in locomotor exploration with increasing age up to 78 days of age in rats; locomotor exploration then decreased. Thus, under constant conditions, there is a tendency for alternation and exploration to increase in both human and nonhuman Ss. However, the lack of monotonicity may be restricted to human alternation and nonhuman exploration.

The data from Ss in the different start position groups are more difficult to interpret. Essentially, there is no change in the rate of alternation for these groups. For each age group there is a greater tendency to alternate choice arms (stimuli) than to alternate responses. Although the differences are not significant, there is first a decrease in alternation rate (for 3-, 4-, and 5-year-olds) followed by an increase for 6-year-olds. With young children, stimulus alternation seems to be more potent than response alternation when these tendencies are opposed. If both the same and different groups are considered, it can be asserted that the stimulus alternation tendency is relatively stable over the ages investigated and that there is an increase in the response alternation tendency.

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